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AUTHOR Davidson, Robert E.; Dollinger, Laurel E.
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ABSTRACT

The deep structure description of a sentence marks the actual grammatical relationships that exist among the words. It is in the deep structure that "meaning" is rendered. Two sentences that are marked differently in deep structure might give rise to the same description in surface structure. Three experiments examined the "psychological reality" of deep structure variations for sentences of the language. Analyses of a variety of dependent variables from a variety of experimental paradigms with two different populations suggested that deep structure variations produce differential effects in learning and recall. Two experiments with university students using free recall and cued recall paradigms indicated that transitional error probabilities could detect different recall patterns reflecting the deep structure variations. A third experiment with second grade children revealed that relatively greater facilitation of learning characterized sentences where an integral subject-object relationship could be specified between the paired items in some deep structure form. (Author)

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TECHNICAL REPORT NO. 110

THE EFFECTS OF DEEP STRUCTURE VARIATIONS IN SENTENCES: FREE RECALL AND PAIRED-ASSOCIATE LEARNING

FROM THE PROJECT ON
SITUATIONAL VARIABLES AND
EFFICIENCY OF CONCEPT LEARNING

WISCONSIN RESEARCH AND DEVELOPMENT
CENTER FOR
COGNITIVE LEARNING

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Technical Report No. 110

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By Robert E. Davidson and Laurel E. Dollinger

Report from the Project on Situational Variables
and Efficiency of Concept Learning

Herbert J. Klausmeier and Robert E. Davidson
Principal Investigators

Wisconsin Research and Development
Center for Cognitive Learning
The University of Wisconsin
Madison, Wisconsin

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This Technical Report is from the Situational Variables and Efficiency of Concept Learning Project in Program 1. General objectives of the Program are to generate new knowledge about concept learning and cognitive skills, to synthesize existing knowledge, and to develop educational materials suggested by the prior activities. Contributing to these Program objectives, the Concept Learning Project has the following five objectives: to identify the conditions that facilitate concept learning in the school setting and to describe their management, to develop and validate a schema for evaluating the student's level of concept understanding, to develop and validate a model of cognitive processes in concept learning, to generate knowledge concerning the semantic components of concept learning, and to identify conditions associated with motivation for school learning and to describe their management.

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ABSTRACT

The deep structure description of a sentence marks the actual grammatical relationships that exist among the words. It is in the deep structure that "meaning" is rendered. Two sentences that are marked differently in deep structure might give rise to the same description in surface structure.

Three experiments examined the "psychological reality" of deep structure variations for sentences of the language. Analyses of a variety of dependent variables from a variety of experimental paradigms with two different populations suggested that deep structure variations produce differential effects in learning and recall.

Two experiments with University students using free-recall and cued-recall paradigms indicated that transitional error probabilities, i.e., errors in word-to-word transitions, could detect different recall patterns reflecting the deep structure variations.

A third experiment with Second Grade children serving as Ss in a paired-associate paradigm revealed that relatively greater facilitation of learning characterized sentences where an integral subject-object relationship could be specified between the paired-items in some deep structure form.

I
INTRODUCTION

DEEP STRUCTURE VARIATIONS: FREE-RECALL LEARNING

Recent linguistic theory postulates a "deep structure" to any sentence in the language (Chomsky, 1965). The deep structure description marks the actual grammatical relationships that exist in the sentence. Two sentences which are marked differently in their underlying structure might give rise to sentences which have the same constituent descriptions in "surface structure." Thus, while two sentences may be the same in surface structure,

(i) Delicate lace was produced by tailors.

(ii) Delicate lace was produced by hand.

the grammatical relations that exist in deep structure are markedly different. In (i) tailors actually serves as the logical subject, and the passive sentence can be made active: Tailors produced delicate lace. In (ii) hand is actually a part of a manner adverbial modifier and the subject of the sentence is not stated.

Psycholinguistic research has attempted to demonstrate that if Ss are responsive to deep structure when they process sentences, then they should show behavioral differences in some kind of appropriate task. For example, Fodor and Garrett (1967) found that relative pronoun cues in surface structure made sentences easier to understand because such cues signaled important relationships in deep structure. Also, the research of Blumenthal (1967) and Blumenthal and Boakes (1967) indicates that, under certain conditions, the number of sentences recalled is more a function of deep structure than it is of surface structure descriptions. The work of Savin and Perchonock (1965) suggests that sentences may be coded in memory in a way that parallels their deep structure descriptions.

On the other hand, the surface description of sentences seems to be the more important determiner in perceptual tasks such as speech perception (Fodor & Bever, 1965) or reading (Mehler, Bever, & Carey, 1967). However, the basically nonperceptual experiments of sentence learning over trials, in which the number of transitional errors between adjacent words in the sentence was the dependent measure, have consistently shown that error patterns follow the constituent structure at the surface (Johnson, 1965). Certainly a sentence learning task requires the processing of sentences in memory and the question that arises is, will transitional error probability (TEP) patterns be responsive to the deep structure differences in sentences that have the same surface structure? Experiments I and II address themselves to this question in a free-recall task and a cued-recall task respectively.

DEEP STRUCTURE VARIATIONS: PAIRED-ASSOCIATE LEARNING

The syntactic facilitation of paired-associate (PA) learning is well documented (Jensen & Rohwer, 1963; Davidson, 1964; Rohwer, 1966). Recent attempts to specify the conditions for syntactic facilitation have examined, inter alia, semantic constraint (Rohwer & Lynch, 1966), intralist similarity (Rohwer & Lynch, 1967), and implied action differences in transitive verbs (Rohwer & Levin, in press). Recently, in a study which examined sentence contexts in PA learning (Rohwer, Shuell, & Levin, 1967), it was observed that the entire sentence, its structural configuration, may be the functional stimulus for the facilitating effect. This observation can be related to current linguistic theory.

Chomsky (1965, 1968) has drawn a distinction between the "surface" and "deep" structure description of a sentence. According to this view, the structure of a sentence in its manifest or surface form might not account for all the complexity perceived by the hearer. That

is, while the surface structure of two sentences may be alike, the deep structure can be very different. It is the deep structure that signals the actual grammatical relationships that exist in the sentence. To understand or interpret a sentence is to recover the grammatical relationships that exist in deep structure.

Recent experiments suggest that surface structure descriptions are important to perceptual tasks such as speech perception (Fodor & Bever, 1965) and reading (Mehler, Bever, & Carey, 1967), while deep structure seems to be the important determiner in memory (Savin & Perchonock, 1965), and sentence interpretation (Fodor & Garrett, 1967).

The following examples from Blumenthal (1967) might make the linguistic distinction clear:

(i) The child was warmed by the stove.

(ii) The child was warm by the stove.

By the mere omission of the suffix "--ed" from the verb, the word "stove" changes its function from logical subject to part of an adverbial modifier. Thus, the two sentences have the same constituent phrase structure at the surface but they differ markedly in deep structure.

Another way of putting this is to say that the transformational history of the two sentence strings are different. In (a), neither the underlying structure nor the transformations leading to the manifest passive form preclude some active representation, i.e., The stove warmed the child. This active paraphrase highlights an integral relationship between the [logical] subject and object of the sentence. In (b), a similar relationship cannot be specified, and the manifest passive form has no intimate link to some active paraphrase.

Experiment III examines the effects of deep structure variations in PA learning. Paired-associate items were embedded in sentences alike in their surface configuration but different in their deep structure. With the to-be-learned associates functioning as subject, object, or adverbial, relatively greater facilitation might be expected for those sentences in which the first and second nouns (i.e., the paired items) bear an integral subject-object relationship. A similar relationship does not exist between the nouns of the adverbial kind.

For each sentence kind both the first and second nouns were used as stimulus in the PA task. In view of the results of Blumenthal (1967), there should be little difference in facilitation of PA learning when the first noun acts as the stimulus because it fulfills the same function in both kinds of sentences. However, when the second noun is used as stimulus, it should favor those sentences where it functions as subject.

II
THE SENTENCE LEARNING EXPERIMENTS

EXPERIMENT I

METHOD

Subjects

Forty students at the University of Wisconsin served as Ss fulfilling a course requirement. Twenty Ss were assigned at random to the treatments.

Materials

Ten sentences of the manner-adverbial kind (MA) and ten of the full-passive kind (FP) were constructed. Examples:

MA Important messages were dispatched by wire.

FP Important messages were dispatched by governments.

Notice that the constituent phrase structure at the surface is the same for both types of sentence. The structure was always of the form:

adjective-noun-was/were-verb-by-noun.

The sentences were recorded on tape. The reading time for each was approximately five seconds, with a slight pause between sentences.

Procedure

Small groups of Ss (4 to 8 in each group) listened to either MA or FP sentences over five learning-test trials. For each trial, the S heard a different random arrangement of the 10 sentences. After the last sentence was read for the learning portion of the trial, the Ss were tested for their recall. They were given 3 minutes to write down the words they could remember. Booklets with five pages (trials) were provided, and each page contained 10 separate lines with six dashes to the line. The Ss were encouraged to guess words and their locations in sentences.

Scoring

Three different kinds of scores were computed for each S. The first of these was the number of words correct at the constituent word level, i.e., adjective...noun...main verb...noun (only the main verb was scored because of the constant (...was/were...by...) pattern). The constituent word scores were summed over the 10 sentences for each trial. Thus, four scores for the number of adjectives, main verbs, etc., were computed for each subject at each trial.

A second kind of score, the TEP, was computed for each S. The TEP for each left-to-right, word-to-word (again ignoring the (... was/were...by)) transition within each sentence was determined by dividing the frequency that a word following a transition was incorrect by the frequency that the word before the transition was correct. That is, for the first transition (adjective...noun) in the example sentences, the TEP would be the frequency that messages was incorrect, given that important was correct, divided by the frequency that important was correct. There are three transitions in the test sentences. They have the following pattern: adjective to noun (TEP_1), noun to main verb (TEP_2), main verb to noun (TEP_3). This last noun is, in fact, the logical subject in FP but is part of the adverbial modifier in MA. A TEP for each transition was obtained by summing over the sentences and over trials for each S.

A third kind of score computed for each S was the deep-structure transitional error probability (DTEP). It was computed by the TEP procedure, but here the transitions were ordered differently. A $DTEP_1$ score was for the transition

between the logical-subject noun (or the manner-adverbial noun in MA sentences) and the main verb. A $DTEP_2$ transition existed between the main verb and adjective, and a $DTEP_3$ transition was between adjective and noun (e.g., Governments ($DTEP_1$) dispatched ($DTEP_2$) important ($DTEP_3$) messages). Note that the TEP_1 $DTEP_3$ is the same adjective-to-noun transition.

The justification for the DTEP score is that it should be sensitive to the passivization transformation that intimately links FP passive sentences and their active representation to some deeper structure. Similar links do not exist between MA passives and some active representation, or between these MA sentences and some deep structure which the DTEP score would reflect.

RESULTS

A repeated measures analysis of variance for the words-correct measure showed differences in recall for the various constituent words ($F = 24.24$, $df = 3/114$, $p < .001$) and, of course, for trials. The mean number of words correct per trial at each constituent word level was: adjective = 6.29, noun = 6.45, main-verb = 5.50, noun = 6.42. A multivariate analysis of variance for the more interesting contrast between the sentence groups (MA vs. FP) indicated no difference ($F = 1.15$, $df = 4/35$).

Table 1 presents the mean transitional error probabilities for this experiment.

Tests among the error scores at each transition point were not carried out. Typically, significant differences are found (Johnson, 1965). Of interest to this study are tests between the sentence groups for each transition point. Of particular interest are the TEP_3 and the $DTEP_1$ transitions. Mann-Whitney tests indicated no differences at any transition for the TEP scores. This result was not entirely unexpected since the surface structure of the two kinds of sentences do not differ. However, the most critical left-to-right transition in surface structure is that of TEP_3 which moves from main verb to manner adverbial noun or to logical subject in the MA and FP sentences, respectively. A test of the TEP_3 transition produced a nonsignificant U of 192.5.

For the DTEP scores, however, the MA and FP groups differ for $DTEP_1$. A normal approximation to the U statistic was significant ($Z = 2.69$, $p < .004$). It appears that Ss recall the same number of words, but the pattern of recall is different for the two groups.

Table 1

Transitional Error Probabilities for Each Kind of Sentence and Transition

Transition	Sentence	Transition Number 1	2	3
TEP	MA[a]	.0992	.2514	.1029
	FP[b]	.0939	.2309	.1021
DTEP	MA[c]	.2749	.1211	.0992
	FP[d]	.1944	.1361	.0939

[a] Important messages dispatched wire.

[b] Important messages dispatched governments.

[c] Wire dispatched important messages.

[d] Governments dispatched important messages.

EXPERIMENT II

METHOD

Subjects

Sixty students at the University of Wisconsin served as Ss.

Materials

The tapes of Experiment I were used.

Procedure

Essentially the same procedure of Experiment I was used here. The booklets were changed to meet design requirements.

Design

Four independent groups were established by providing two different kinds of sentences (MA,

FP) and Cues (First noun, Second noun). Depending upon his group assignment, the S received a booklet which provided cue words for each sentence at every trial. Either the first noun of the sentence or the second noun of the sentence was printed. The Ss were encouraged to use the cue words to aid them in recall. This design is, in gross outline, that of Blumenthal (1967). Predictions were similar. That is, the Ss serving under the FP condition and who received the second noun (logical subject) as a cue were expected to be facilitated in their recall.

Scoring

With some necessary changes, the three kinds of scores computed in Experiment I were calculated here. Because different cue words were provided, word constituent scores were not meaningful. Instead, the number-of-words-correct score was a summation of the three remaining words in each of the 10 sentences for each trial; these were cast in a 2 x 2 x 5 repeated measures analysis of variance. The TEP score and DTEP score were determined as before. It can be noted that either larger or non-existent error probabilities for some cells would occur because cue words might constitute one side or the other of a transition.

RESULTS

Analysis of the words-correct measure revealed a significant cue effect ($F = 4.59$, $df = 1/56$, $p < .05$) with the first noun providing greater facilitation of recall. Neither the Sentence effect ($F = 2.28$; $df = 1/56$) nor the predicted interaction ($F < 1.00$) was found to be significant.

In some conditions, the cues that were provided made up the right hand side of the transition; therefore, certain transitional errors did not exist. But despite this general limitation, the critical transitions could be tested. Again the tests of interest contrast the MA and FP groups. On Mann-Whitney tests, only the $DTEP_1$ transition scores were significantly different ($Z = 2.57$; $p < .005$) with MA = .3474 and FP = .2869.

DISCUSSION

Transitional error patterns have consistently shown themselves to be sensitive to sentence surface structure differences. The results of these experiments suggest that the metric may be very sensitive to deep structure differences as well. Of course the addition or elaboration of any good operational test to the study of language is especially needed at this time. The psycholinguistic researcher has reached the point where he no longer is content merely to demonstrate the verities of a linguistic competence model; instead, he is ready to look at language behavior differently than he has in the past. He is ready to postulate psychological competencies with respect to language that are likely to be, at the same time, at variance with any fully elaborated system of linguistic operations and with any traditional psychological theory as well.

III
THE PAIRED-ASSOCIATE EXPERIMENT

EXPERIMENT III

METHOD

Subjects

Fifty-four Second-Grade children of mixed ability levels were recruited from one school in a semi-rural community.

Materials

Forty pictures were made into transparencies and set into 35mm mounts for slides. The pictures were simple line drawings of familiar objects found in primer workbooks.

The pictures were paired in a way to avoid obvious associations, and sentences of an integral passive (IP) or manner adverbial (MA) kind were constructed for each pair. The surface structure of the sentences was always of the form:

adjective-noun-was/were-verb-by-noun

Between the IP and MA versions, the verbs and plural suffixes were changed to signal the appropriate interpretation of the sentence. Examples:

MA Soft bread was delivered by pony.

IP Soft bread was tasted by ponies.

Two response booklets were provided for each S, one for each trial. These consisted of a face sheet and 20 identical response pages. Each response page depicted all 20 response items. Ten of these responses had appeared as the first noun in the sentence, and ten had appeared as the second noun. Three practice pages showing geometrical figures were included in the booklets used for the first trial.

Apparatus

The apparatus allowed a fully automated experiment. Pairs of slides were shown on a screen in a semi-darkened room from two Kodak Carousel 800 projectors operated from a single remote control unit. Sentences were recorded on one track of stereo recording tape. On the second track of the tape a timed signal was recorded by means of a Kodak sound synchronizer. Thus, the slide projectors were programmed to change slides automatically and in conjunction with the playback of the appropriate verbalizations. The timing signal was not audible to the Ss. Tapes were played on a Sony TC-200 stereo tape recorder.

Design

A three-group multivariate design was employed using a three-level independent factor of mediation (IP, MA, Control), and two bi-level repeated factors of trials and nouns. Thus, each S was assigned to one of three groups and four observations were obtained, two at each trial for the first and second noun.

Procedure

A recognition PA method with small groups of children was employed (Davidson, 1964). The general nature of the task was explained and the Ss were familiarized with the location of the pictures on the response pages by asking them to point to each picture as it was named by E. This familiarization was included to avoid the loss of correct responses because of difficulty in locating items.

Specific instructions were then stated. Subjects in the mediated conditions were told to look at the pictures, listen to the sentences,

and remember which two pictures belonged together. It was emphasized that the sentences would help them remember the pairs. They were also informed that the response trials would proceed at a rapid pace and that they must work quickly, turn to the appropriately numbered page as instructed by the tape-recorded voice, and follow the page numbers carefully. Guessing was encouraged.

The instructions for the control condition were identical except that in place of any reference to the sentences Ss were told that the pictures would be named as they were shown.

Three practice items were then performed using geometric figures on actual slides. The practice items illustrated the fact that the test stimuli would be in a different order than the pairs and that either the first or second item could be the stimulus, although E did not state these facts explicitly.

The actual experimental trials were then begun. For the study portion of each trial all 20 pairs of slides were shown at 4-second exposures, allowing an additional half-second for the projectors to change slides. In the experimental groups the pairs were accompanied by the spoken sentences. All sentences were either of the IP or MA construction. For the control group a more traditional paired-associates procedure was followed in that the pictures were merely named as they were shown.

Timing for the test or recognition portion was 8 seconds. As each of the 20 stimuli was shown and named, Ss were to circle the other (missing) member of the pair on their response sheets.

The procedure for the second trial was identical to the first except for the use of briefer instructions and omission of the practice items.

There was an approximate 2-minute interval between trials as new booklets were distributed, slide-holders were changed, and portions of the instructions were repeated.

The entire experimental session ran less than 30 minutes per group.

RESULTS

The dependent measure was the number of correct responses. A response was scored as correct if the appropriate item on the appropriate page and only that item was circled by S.

The results presented here are based on a total of 18 Ss in each experimental group and 16 Ss in the control group. Two of the original 18 Ss were lost from the control group because of their inability to keep up with the pace of the responses and resultant cessation of performance.

Means and standard deviations for noun and trial totals are presented in Table 2.

Initially a Dunnet statistic for total scores was performed which indicated that both experimental conditions differed significantly from the control group (Integral Passive vs. Control, $t = 6.5$, $p < .001$; Manner Adverbial vs. Control, $t = 4.7$, $p < .001$).

The magnitude of the effect was analyzed by means of the ω^2 statistic, which indicated that approximately 62% of the variance could be accounted for by the three main conditions. (This is comparable to the results of other investigators in similar mediation studies, especially Davidson (1964), $\omega^2 = .73$).

The Dunnet test statistic revealed that, as was expected, the mediating materials used in

Table 2

Means and Standard Deviations of Correct Responses for the Three Independent Groups

Mediation Type		Totals			
		Trial 1	Trial 2	Noun 1	Noun 2
Integral Passive (N = 18)	M	11.06	15.76	12.06	14.78
	SD	3.57	3.51	4.04	3.10
Manner Adverbial (N = 18)	M	7.94	13.50	9.72	11.72
	SD	3.26	4.05	3.68	3.39
Control (N = 16)	M	2.63	5.38	4.00	4.00
	SD	1.59	3.50	2.19	2.22

the experimental groups produced a very strong and distinct facilitation of learning over the control group, which used the traditional, nonmediated procedure of PA learning. Therefore, the control group was omitted from further analysis in order to permit a more precise examination of the effects of major interest.

A multivariate analysis of variance was performed for the two mediation groups. The overall joint multivariate test of nouns within trials (all variates) was of sufficient magnitude to allow the associated set of contrasts for trials, nouns, and total score to be formed and tested ($F = 2.07$, $df = 4/31$, $p < .11$). The total score contrast was a univariate test indicating that the two mediation groups differ significantly ($F = 6.03$, $df = 1/34$, $p < .02$). The subsequent multivariate tests and their associated univariate statistics are presented in Table 3. The joint tests for trials and nouns and an inspection of the related means show that the IP condition had the greater number of correct responses in all cases. The associated univariate statistics were used to examine the locus of these effects. The several tests indicated that the two groups differed significantly for the Trial 1 and Noun 2 response scores.

Table 3

Multivariate Analysis of Variance Summaries and Associated Univariate Statistics

Joint Multivariate Analysis of Variance of Trials (2 Variates)

F	DFHYP	DFERR	P
3.61	2.00	33.00	< .04

Univariate Tests of Trials:

	F(df 1/34)	MS	P
Total-Trial 1	7.44	87.11	< .01
Total-Trial 2	3.26	46.69	< .08

Joint Multivariate Analysis of Variance of Nouns (2 Variates)

F	DFHYP	DFERR	P
3.91	2.00	33.00	< .03

Univariate Tests of Nouns:

	F(df 1/34)	MS	P
Total-Noun 1	3.29	49.00	< .08
Total-Noun 2	7.96	84.03	< .008

DISCUSSION

The finding that syntactic mediation is superior to a control condition was hardly unexpected. The phenomenon is so well documented that any discussion is unnecessary. In the present experiment, once the control group had provided an estimate of some minimum baseline performance, it had served its purpose and was eliminated from further consideration. Future experiments that aim at assessing the effects of various kinds of syntactic mediation might deem it unnecessary, except in special cases, to include a traditional PA control. Such a group seems to add little to the assessment of syntactic mediators.

The major finding of this study does lend support to the assertion that deep structure variations may be expected to affect differentially PA learning. A full explanation as to the nature of the effect must await further study; however, the overall superiority of the IP condition suggests that the integral subject-object relationship between the paired items in some underlying deep structure form has a general facilitating effect. This result is reminiscent of the hypothesis of Miller (1962) which suggested that it is the "kernel" (read, underlying structure of the sentence) plus some transformational footnote that is stored in memory. Linguistic theory has changed somewhat since the Miller writing, but the essence of the hypothesis seems cogent with respect to these experimental results.

The more analytic explanation was not supported, i.e., the explanation that would attribute the facilitation specifically to the mediating sentences in which the stimulus functioned as subject. Indeed, the univariate results suggest the opposite. The use of the first noun as stimulus produced better recognition than did the use of the second noun. An explanation for the discrepancy is not readily available, especially since the findings here seem counter-intuitive. As the study of Blumenthal (1967) suggests, it would seem logical that when nouns differ in function, their effectiveness as stimuli should also differ.

Of additional interest in this study was the relatively stronger effect between kinds of sentences found at Trial 1. This is consistent with the findings of Rohwer (1966) that syntactic facilitation seems to have its greatest effect on the initial trial. However, it must be remembered that syntactic mediators are extremely powerful facilitators of PA learning, even with 20 pairs to be learned, and many children are at asymptote at the second trial.

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REFERENCES

Blumenthal, A. Promoted recall of sentences. Journal of Verbal Learning and Verbal Behavior, 1967, 6, 203-206.

Blumenthal, A., and Boakes, R. Prompted recall of sentences, a further study. Journal of Verbal Learning and Verbal Behavior, 1967, 6, 674-767.

Chomsky, N. Aspects of the theory of syntax. Cambridge: M.I.T. Press, 1965.

Chomsky, N. Language and the mind. New York: Harcourt, Brace & World Inc., 1968.

Davidson, R. E. Mediation and ability in paired-associate learning. Journal of Educational Psychology, 1964, 55, 352-356.

Fodor, J. A., and Bever, T. G. The psychological reality of linguistic segments. Journal of Verbal Learning and Verbal Behavior, 1965, 4, 414-420.

Fodor, J. A., and Garrett, M. Some syntactic determinants of sentential complexity. Perception and Psychophysics, 1967, 2, 289-295.

Jensen, A. R., and Rohwer, W. D., Jr. Verbal mediation in paired-associate and serial learning. Journal of Verbal Learning and Verbal Behavior, 1963, 1, 346-352.

Johnson, N. F. The psychological reality of phrase-structure rules. Journal of Verbal Learning and Verbal Behavior, 1965, 4, 469-475.

Mehler, J., Bever, T., & Carey, P. What we look at when we read. Perception & Psychophysics, 1967, 2, 213-218.

Miller, G. A. Some psychological studies of grammar. American Psychologist, 1962, 17, 748-762.

Rohwer, W. D., Jr. Constraint, syntax and meaning in paired-associate learning. Journal of Verbal Learning and Verbal Behavior, 1966, 5, 541-547.

Rohwer, W. D., Jr. & Lynch, S. Semantic constraint in paired-associate learning. Journal of Educational Psychology, 1966, 57, 271-278.

Rohwer, W. D., Jr. & Lynch, S. Form class and intralist similarity in paired-associate learning. Journal of Verbal Learning and Verbal Behavior, 1967, 6, 551-554.

Rohwer, W. D., Jr., Shuell, T. J., & Levin, J. R. Context effects in the initial storage and retrieval of noun pairs. Journal of Verbal Learning and Verbal Behavior, 1967, 6, 796-801.

Rohwer, W. D., Jr. & Levin, J. R. Action, meaning and stimulus selection in paired-associate learning. Journal of Verbal Learning and Verbal Behavior (in press).

Savin, H. B., & Perchonock, E. Grammatical structure and the immediate recall of English sentences. Journal of Verbal Learning and Verbal Behavior, 1965, 4, 348-353.

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